WHAT IS CLAIMED IS:

1. An apparatus for processing semiconductor substrates, the apparatus comprising:

a chamber defining a processing region therein;

a substrate support disposed in the chamber to support a semiconductor substrate;

at least one nozzle extending into the chamber to introduce a process gas into the chamber through a nozzle opening; and

at least one heat shield, each heat shield disposed around at least a portion of one of the at least one nozzle, the heat shield having an extension which projects distally of the nozzle opening of the nozzle and which includes a heat shield opening for the process gas to flow therethrough from the nozzle opening.

2. The apparatus of claim 1 wherein the heat shield comprises a ceramic material.

3. The apparatus of claim 1 wherein the heat shield comprises a material selected from the group consisting of aluminum oxide, aluminum nitride, and silicon carbide.

4. The apparatus of claim 1 wherein the extension of the heat shield projects distally of the nozzle opening by a distance of between about a radius of the nozzle and about a diameter of the nozzle.

5. The apparatus of claim 1 wherein the heat shield is disposed around substantially the entire nozzle extending inside the chamber.

6. The apparatus of claim 1 wherein a plurality of nozzles are disposed around the substrate support and each nozzle has a heat shield disposed around at least a portion thereof.

7. The apparatus of claim 6 wherein the heat shields are disposed around the substrate support and configured such that the heat shield openings of the heat shields are disposed radially outwardly of a periphery of the semiconductor substrate.

8. The apparatus of claim 1 wherein the heat shield comprises a hollow, cylindrical member.

9. A heat shield for shielding a nozzle extending into a chamber to introduce a process gas into the chamber through a nozzle opening, wherein the chamber defines a processing region therein and has a substrate support to support a semiconductor substrate for processing in the chamber, the heat shield comprising:

a hollow member configured to be coupled with the nozzle and having an internal dimension sufficiently large to be disposed around at least a portion of the nozzle, the hollow member having an extension which projects distally of the nozzle opening of the nozzle and which includes a heat shield opening for the process gas to flow therethrough from the nozzle opening.

10. The heat shield of claim 9 wherein the hollow member is cylindrical and has an internal cross-section which is slightly larger than an external cross-section of the nozzle.

11. The heat shield of claim 9 wherein the hollow member comprises a ceramic material.

12. The heat shield of claim 9 wherein the extension of the heat shield is sized to project distally of the nozzle opening by a distance of between about a radius of the nozzle and about a diameter of the nozzle.

13. A method of processing semiconductor substrates, the method comprising:

placing a substrate on a substrate support in a chamber defining a processing region therein;

introducing one or more process gases through at least one nozzle which extends into the chamber and which has a nozzle opening for the one or more process gases to flow therethrough;

applying energy in the processing region to perform a process on the substrate; and

providing a heat shield for the nozzle, the heat shield being disposed around at least a portion of the nozzle to reduce a temperature rise of the nozzle from the process performed on the substrate, the heat shield having an extension which projects distally of the nozzle opening of the nozzle and which includes a heat shield opening for the process gas to flow therethrough from the nozzle opening.

14. The method of claim 13 wherein applying energy in the processing region comprises generating a plasma in the processing region.

15. The method of claim 14 wherein generating the plasma in the processing region comprises applying a source RF power of at least about 10 kW.

16. The method of claim 13 wherein the process performed on the substrate comprises forming a layer from the one or more process gases.

17. The method of claim 16 wherein the layer fills a gap in the substrate and the gap has a width of at most about 90 nm.

18. The method of claim 16 wherein the layer fills a gap in the substrate and the gap has an aspect ratio of at least about 4.

19. The method of claim 13 wherein the extension of the heat shield projects distally of the nozzle opening by a distance of between about a radius of the nozzle and about a diameter of the nozzle.

20. The method of claim 13 wherein a plurality of nozzles having heat shields are disposed around the substrate, and wherein the heat shields are disposed around the substrate and configured such that the heat shield openings of the heat shields are disposed radially outwardly of a periphery of the substrate.